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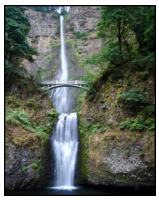

Controlling environmental crisis appraisal through knowledge, vividness, and timing

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ABSTRACT

Effective communication during disasters ensures that the public realizes the urgency of the crisis. The present research aims to identify factors that influence the perceived urgency and severity of a chronic water crisis in the Southwest United States that may lead to a future megadrought. Findings show *knowledge* about the interdependence of water and power infrastructures, *vividness* of the dreadful consequences of droughts, and *time* of crisis jointly increase perceived urgency and severity of the crisis, thus suggesting three directions for future research. First, knowledge-based interventions may be most effective when the knowledge presented is not already salient. Second, vividness of the crisis could increase the perceived urgency of a crisis. Third, design of future interventions should take into account individuals' competing needs to satisfy desires for consuming resources versus conserving them; individuals may be less amenable to sustainability interventions when their desire for resources is intense.

1. Introduction

1.1. Environmental crisis perception

In recent decades, there has been growing concern to address the effects of human activity on environmental degradation. For example, in the Southwest region and Central Plains of North America, climate change is expected to increase drought severity in the coming decades, posing a severe threat to our environment, ecosystems, economy, and society (Cook, Ault, & Smerdon, 2015; Meko et al., 2007; Woodhouse & Overpeck, 1998). If emission of greenhouse gases and depletion of nonrenewable groundwater reservoirs continue to go unchecked, the odds of a megadrought hitting Arizona for 35 years or longer this century would be between 70 and 99 percent (Ault et al., 2018). A disaster of this scale would cause a major water shortage, which would result in more wildfires, destroy wildlife habitats, disrupt the economy, and negatively impact the health of the public (Benson & Clay, 1998; Prokurat, 2015; Vicente-Serrano, 2007).

To minimize disruptions caused by megadroughts to the electric grid and the water delivery and treatment systems, it is critical for the public to understand the severity and urgency of a crisis *both* to water and power infrastructures. One impact of droughts which may be less obvious to the general public is the damage caused to power systems due to existing interdependencies between the water supply system and the electric grid (Gold & Webber, 2015). Power plants require water in many stages of power generation, most significantly for the cooling processes, that accounts for 40% of all fresh water use (Kenny et al., 2009). Power plants then provide energy for pumping, cleaning, and delivering fresh water to users, in addition to supplying electricity to power households and industries (Schnoor, 2011).

According to the Crisis and Emergency Risk Communication (CERC) model, the first stage of monitoring and responding to a crisis involves the public's understanding and recognition of the crisis (Reynolds & Seeger, 2005). As it relates to the water shortage, a recent survey study of a representative sample of U.S. residents found that water shortages are not a major concern for most people (Garcia-Cuerva, Berglund, & Binder, 2016). Previous research has shown that environmental perceptions predict engagement in sustainable behaviors, including reducing emissions of greenhouse gasses (Beckage et al., 2018; Tikir & Lehmann, 2011), making perceptions an important first-step consideration for intervention. As an initial step, it is important to increase the public's perceived urgency and severity of water shortages before behavioral changes can be adopted on a large scale.

Previous research found that the adoption of water-conserving behaviors such as acceptance of recycled water are predicted by a number of psychological factors, including positive environmental attitudes and knowledge (Dolnicar, Hurlimann, & Grün, 2011). Therefore, the present research seeks to address both psychological and contextual factors that

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influence the public perception of the urgency and severity of the imminent megadrought in the Southwest of the United States. Specifically, we ascertain the impact of three factors pertinent to crisis communication strategies: (1) presented knowledge about the interdependence of the water and power infrastructures (*Knowledge*), (2) visibility of the dreadful consequences of droughts (*Vividness*), and (3) time of crisis presenting competing needs to satisfy desires for consuming resources as well as to conserving them (*Timing*).

1.2. Knowledge

One reason for the lack of perceived urgency surrounding environmental crisis is lack of knowledge about the potential consequences of current behaviors (National Science Board, 2018). Although the benefits of engaging in environmentally responsible behaviors can be clear, people often are not rational decision makers (Ariely, 2009; Vandenbergh, Carrico, & Bressman, 2011), often discounting future environmental consequences to prioritize current physical and economic benefits (Carrico, Vandenbergh, Stern, & Gardner, 2011; Clayton et al., 2016). According to the knowledge deficit model of science communication and understanding, a lack of public support regarding a scientific topic is often due to scientific illiteracy or ignorance (Miller, 1983). Therefore, an increased level of scientific knowledge is necessary for public perception and attitude regarding a scientific issue to align with expert opinion (for meta-analytic support, see Allum, Sturgis, Tabourazi, & Brunton-Smith, 2008).

Presenting relevant information about environmental risks may help individuals bridge the psychological gap between their current behaviors and future consequences. Studies investigating the relationship between knowledge and pro-environmental perceptions and behaviors have largely been correlational in nature (e.g., Kuhlemeier, Van Den Bergh, & Lagerweij, 1999). For example, in a year-long longitudinal study in New Zealand, researchers found that knowing more about consequences of climate change predicts increased concern about environmental risks, such as global warning, which in turn lead to greater perceived efficacy and responsibility to participate in mitigating these risks (Milfont, 2012). Knowledge also predicts environmentally-friendly attitudes and behaviors (Haron, Paim, & Yahaya, 2005), including acceptance of water-conserving policies such as water reuse (Dolnicar et al., 2011). Similarly, education is a significant predictor of attitudes toward water reuse among residents of Arizona (Rock, Solop, & Gerrity, 2012).

While many people are familiar with droughts such as the 1930s 'dustbowl' or the ongoing drought in California and the Southwest of the United States, it is less likely that many people have considered the implications of a drought lasting for over 35 years. Additionally, while the effects of a large-scale drought on water supply are apparent, the effects of a water shortage on power supplies are less obvious to the general population because they might not be aware of the interdependence of the two critical infrastructures. Little research has examined how presented knowledge about the interdependence of critical infrastructures, such as water and power systems, affects crisis perception. By providing knowledge about the interdependence of water and power infrastructures, individuals may better understand the urgency of the environmental crises that stem from water shortages.

1.3. Vividness

The imagery people hold regarding an environmental crisis predicts their level of risk perception and policy support (Leiserowitz, 2006). As an example, an individual who vividly imagines melting glaciers when thinking about climate change may be more likely to support pro-environmental public policy. Presenting visual evidence highlighting the impact of environmentally harmful behaviors on familiar locations can influence the perceived urgency of an environmental crisis (Bolsen, Kingsland, & Palm, 2018). For example, a study exposing participants to animated maps of future flooding in two major U.S. cities found that these participants assessed impacts of flooding to be more severe and increased their belief in climate change (Bolsen et al., 2018). Therefore, increasing the vividness of future consequences of environmentally harmful behaviors may help to communicate severity and urgency of an environmental crisis.

Perceptions of urgency about the water crisis affecting the Southwest United States may arise from seeing a continuous decline in water levels over the last decade and from seeing images of the diminishing water levels (e.g., at Lake Mead). Lake Mead is the largest water reservoir in the United States and provides water to nearly 25 million people in Arizona, California, and Nevada (Ecowatch, 2015). Due to over-appropriation and rising temperatures, the water level at Lake Mead has been dropping at an alarming rate of 12 feet per year. This has resulted in a striking white ring, known as the "bathtub ring", exposing the long-submerged shoreline of Lake Mead (Best, 2016; Walsh, 2008). The current study focuses on Arizona residents' perceived urgency of a likely megadrought; visuals of declining regional water levels may help highlight the locality and closeness of the issue and increase assessments of urgency and severity of an impending water crisis.

1.4. Timing

Previous research examined types of saving behaviors that are most amenable for effective interventions (Abrahamse, Steg, Vlek, & Rothengatter, 2005; Gardner & Stern, 1996; Lehman & Geller, 2004; Osbaldiston, 2004). Critical to designing effective interventions is understanding how local contexts and conditions influence individuals' perceptions and behavior. For example, local weather conditions can affect survey responses regarding public policy issues (e.g., climate change; Potoski, Urbatsch, & Yu, 2015). However, one context not directly studied to date is the role of timing in determining the public perception of a crisis. All throughout the year, individuals experience competing needs to satisfy desires for resources as well as to conserving resources. Nevertheless, seasonal changes may influence the intensity of the perception of these competing needs. A relevant analogy here is the Doppler Effect: people feel the siren of an ambulance is louder with a higher pitch when it is approaching them than when it is moving away from them. Recent research demonstrated a similar phenomenon in psychological perceptions of time (Caruso, Van Boven, Chin, & Ward, 2013).

The Psychological Doppler Effect suggests that individuals show a systematic asymmetry in perceiving temporal distance of events, whereby future events are psychologically closer than past events of the same temporal distance (Caruso et al., 2013). By this logic, we predict that people may construe the same environmental crisis differently depending on the time of the crisis (Trope & Liberman, 2003, 2010). People may feel that the hot summer is just around the corner in May (i.e., two months *before* the peak summer in Arizona), whereas people may feel the hot summer is over and far away in November (i.e., two months *after* the peak summer). In the late Spring (May), when the peak summer is perceived as being psychologically intense, an environmental crisis may be perceived as less urgent and severe due to the need to use resources to handle the hot summer becoming more pertinent than a desire to conserve those resources. An individual's desire to save water resources may not override their more intensely felt desire to take a long shower and turn on the air conditioner during the time leading up to a hot summer. We thus predict that people may perceive the severity of an impending crisis differently depending on the time of learning about the crisis.

1.5. Study aims and hypotheses

To recapitulate, the current research aims to identify and address

three factors that may present barriers to the perceived urgency and severity of an environmental crisis: (1) *knowledge* by testing how providing additional information about the interdependence of power and water impacts perceptions of impending environmental crises, (2) *visibility* of the consequences of droughts by testing whether vivid images of the environmental crisis can increase perceived urgency and severity of likely disasters, and (3) *timing* that reflects that competing needs to satisfy desires for resources versus needs to conserving resources will influence how the same environmental crisis will be perceived.

Specifically, we expect to find three main effects (knowledge, vividness, and timing). First, we predict that when presented with additional knowledge about the interdependence between water and power systems, individuals will perceive a crisis as more severe and urgent in terms of power supply. We expect this because the impact of a water crisis on power supplies may not be apparent without knowledge of how power and water systems are interdependent. However, we do not expect that more knowledge about this interdependence will significantly change perceptions of a water crisis since the described water crisis scenario itself already makes this relationship apparent. Moreover, given that all of our participants are Arizona residents, where the severity of water shortage and its potential impact on water supply is frequently discussed, most Arizona residents recognize that the severity and urgency of the water crisis is high. Therefore, we expect that the presented information about the interdependence of water and power systems will not increase perceived urgency and severity of water crisis in Arizona. Second, we predict that when presented with vivid images demonstrating a water crisis, participants will perceive the water crisis as being more severe and urgent compared to participants who do not receive the images. Third, we predict that participants will perceive both water and power crises as being more severe and urgent in the Fall than in the Spring, even when they are presented with the same water crisis. Finally, the present research is the first to include all three of these psychological factors within a single study design. We have no specific hypotheses regarding potential interactions of these factors on crisis perceptions.

2. Methods

2.1. Sample

The sample was 788 (444 males and 344 females) residents living in Maricopa County, Arizona who were recruited through Qualtrics Panel services. Participants completed the survey online through Qualtrics software.[1] Participants received $6 for their participation of this study, which took approximately 10 min to complete (*Mdn* = 10.4 min). We focused on residents in Maricopa county because (a) it is the most populous county in Arizona, with over half of the state's population residing there; (b) residents of the county are serviced by Lake Mead on the Colorado River, which will be described in the current study, and (c) weather conditions within Maricopa county are relatively similar, as compared to the conditions across counties in Arizona.

The mean age of the sample was 47.59 (*SD* = 16.78; range between 18 and 91 years old). The ethnic breakdown of the sample was: 633 Caucasian/European American participants, 63 Latino American/Hispanic/Chicano participants, 27 African American participants, 26 Asian American/Pacific Islander participants, 4 American Indian participants, 2 Middle Eastern participants, and 33 Multicultural participants.

Participants for the study were recruited to complete the study at one of two time points; Spring or Fall. The Fall data collection occurred between November 21st, 2016 and December 2nd, 2016 (approximately two months *after* peak Arizona summer) and the Spring data collection occurred between May 5th, 2017 to May 17th, 2017 (approximately two months *before* peak Arizona summer). In the Fall, 317 (222 male) participants, with a mean age of 41.48, completed the study. In the Spring, 471 (222 male) participants, with a mean age of 51.71, completed the study. Participants, on average, self-identified as middle class and as having completed a 4-year college degree.

2.2. Experimental design

The manipulated conditions included knowledge, vividness, and timing of the study. A 2 (Knowledge: information about the interdependent nature of power and water supply provided vs. no interdependent information provided) x 2 (Vividness: pictures vs. no pictures) x 2 (Timing: survey taken in Spring vs. Fall) between-subjects design was used. Table 1 shows the sample size for each condition. As mentioned above, there were two data collections—the first one occurred approximately two months *after* peak Arizona summer and the second one occurred approximately two months *before* peak Arizona summer. None of the respondents participated in the first data collection were invited to take part in the second data collection. Within each data collection, participants were randomly assigned to one of the eight conditions. All participants began the study by reading a brief newspaper report titled “Is Arizona Running Out of Water?” (Appendix), which described record low water levels in Lake Mead and a chronic water crisis in Arizona.

In the interdependent knowledge condition, participants then read the information about “Water-Energy Nexus” (Appendix), a brief report summarizing the symbiotic relationships between water and power infrastructures. The inclusion of this interdependence information was the only difference between the interdependent knowledge and no interdependent knowledge conditions. In the vividness condition, respondents were presented with images and figures illustrating the declining water levels over time. The inclusion of the pictures acted as a vividness manipulation by making the declining water levels more salient compared to the no-pictures condition. The timing manipulation involved administering the study at two different times of the year (Spring vs. Fall). Participants in all conditions were then asked to imagine themselves in the chronic water crisis scenario presented to them at the beginning of the survey and they completed the questions about their perceptions of water and power crises.

2.3. Measures

Water Crisis Perception. To assess how individuals perceived the water crises in Arizona, participants responded to two questions on a six-point Likert scale (1 - “not at all”, 6 - “extremely”): (1) “How severe is the **water** shortage problem in Arizona?” (2) “How urgent is the **water** shortage problem in Arizona?” The correlation between perceived urgency and severity of a water crisis was 0.914 ($p < .001$), thus we computed a composite score of water crisis by averaging responses to these two questions. Across conditions, the mean composite water crisis perception was 4.81 (*SD* = 1.21), suggesting that residents in Arizona across conditions recognized the severity of the water crisis.

Power Crisis Perception. Similarly, participants responded to two questions about power crisis on a six-point Likert scale (1 - “not at all”, 6 - “extremely”): (1) “How severe is the **power** shortage problem in Arizona?” (2) “How urgent is the **power** shortage problem in Arizona?” The correlation between perceived urgency and severity of power crisis was 0.949 ($p < .001$), thus we computed a composite score of power crisis for further analyses. Across conditions the mean composite power crisis perception was 4.02 (*SD* = 1.44).

[1] We carried out quality checks of the survey data according to the recommendations of Meade and Craig (2012). Removing multivariate outliers using the Mahalnobis distance method and outliers based on total survey duration time did not affect any of the results.

Table 1
Sample sizes for each experimental condition.

Experimental Conditions		Sample Size
Knowledge	With Interdependence Info	n = 381
	Without Interdependence Info	n = 407
Vividness	With Pictures	n = 386
	Without Pictures	n = 402
Timing	Spring	n = 317
	Fall	n = 471

Note: Study n = 788.

3. Results

The current study sought to address the effects of knowledge, vividness, and timing on perceptions of water and power crises. The bivariate correlation between water and power crisis perceptions was significantly positive ($r = 0.67$, $p < .001$), indicating that individuals who perceived the water crisis to be more severe and urgent also perceived the power crisis to be similarly severe and urgent. To test our hypotheses, we conducted two series of 2 × 2 × 2 analyses of variance (ANOVA), one for perceptions of water and another one for perceptions of power crises. There were no significant two- or three-way interactions among the three manipulated factors. The corrected model results were similar for water crisis perceptions when the interactions were included [$F(7, 787) = 6.35$, $p < .001$, $\eta p^2 = 0.05$] or were not included [$F(3, 787) = 14.07$, $p < .001$, $\eta p^2 = 0.05$]. The same was the case for power crisis perceptions when the interactions were included [$F(7, 787) = 5.33$, $p < .001$, $\eta p^2 = 0.04$] or were not included [$F(3, 787) = 11.60$, $p < .001$, $\eta p^2 = 0.04$]. As predicted, there were three significant main effects (knowledge, vividness, and timing) on water or power crisis perceptions.

Knowledge. Fig. 1 illustrates the significant effect of knowledge on crisis perceptions. Presented knowledge about the interdependence between water supply and power supply significantly affected power crisis perception, $F(1, 780) = 25.30$, $p < .001$, $\eta p^2 = 0.03$ (Fig. 1a). Participants who read the interdependence information perceived greater power crisis ($M = 4.28$, $SD = 1.33$) than those who did not ($M = 3.78$, $SD = 1.50$). The main effect of interdependence knowledge was not significant on water crisis perceptions, $F(1, 780) = 0.80$, $p = .371$.

Vividness. Also as predicted, the effects of vividness on both water [$F(1, 780) = 17.85$, $p < .001$, $\eta p^2 = 0.02$] and power crisis perceptions [$F(1, 780) = 6.03$, $p < .05$, $\eta p^2 = 0.01$] were significant (Fig. 1b). Participants who saw the illustrative images of declining water levels perceived greater water crisis ($M = 5.00$, $SD = 1.15$) and power crises ($M = 4.15$, $SD = 1.43$) than those who did not see the images (Water: $M = 4.63$, $SD = 1.25$; Power: $M = 3.90$, $SD = 1.45$).

Timing. Finally, the time of the year when participants were presented with the crisis scenario also significantly affected perceptions of water crisis [$F(1, 780) = 22.93$, $p < .001$, $\eta p^2 = 0.03$] and power crisis [$F(1, 780) = 4.81$, $p < .05$, $\eta p^2 = 0.01$] (Fig. 1c). Participants in the Fall were more likely to perceive the same crisis as more urgent and severe (Water: $M = 5.06$, $SD = 1.07$; Power: $M = 4.15$, $SD = 1.42$) than participants in the Spring (Water: $M = 4.64$, $SD = 1.28$; Power: $M = 3.94$, $SD = 1.46$).

3.1. Demographic control variables

To test whether our findings hold after controlling for age and sex, we conducted analyses of covariance (ANCOVAs), including the three factors of interest in the model as predictors (knowledge, vividness, and timing) as well as age and sex. Overall, the effects of knowledge and vividness on both water and power crisis perceptions, and the effects of timing on water crisis (but not power crisis) perception are robust across respondents of different age and gender groups. Including age and sex in the models did not alter the pattern of main effects for the knowledge, vividness, and timing on water crisis perceptions. The main effects for knowledge and vividness also remained significant on power crisis perception. However, the main effect of timing on power crisis perceptions no longer reached significance with age and sex included in the model, $F(1, 778) = 1.41$, $p > .05$. We re-ran the analysis by entering age and sex separately and found that the main effect of timing on power crisis perception remained significant after controlling for the effects of age, but not so after controlling for the effects of sex. The effect of age was not significant for either water or power crisis perceptions, $Fs < 1.20$, $ps > .05$. Sex had a significant effect on both water [$F(1, 778) = 35.11$, $p < .001$, $\eta p^2 = 0.04$] and power crisis perceptions [$F(1, 778) = 31.38$, $p < .001$, $\eta p^2 = 0.04$]. Men perceived the crises as more urgent and severe (Water: $M = 5.06$, $SD = 1.08$; Power: $M = 4.27$, $SD = 1.40$) than women did (Water: $M = 4.49$, $SD = 1.30$; Power: $M = 3.70$, $SD = 1.44$). Together, these findings suggest that the timing effect may be in part due to the sex differences in crisis perception.

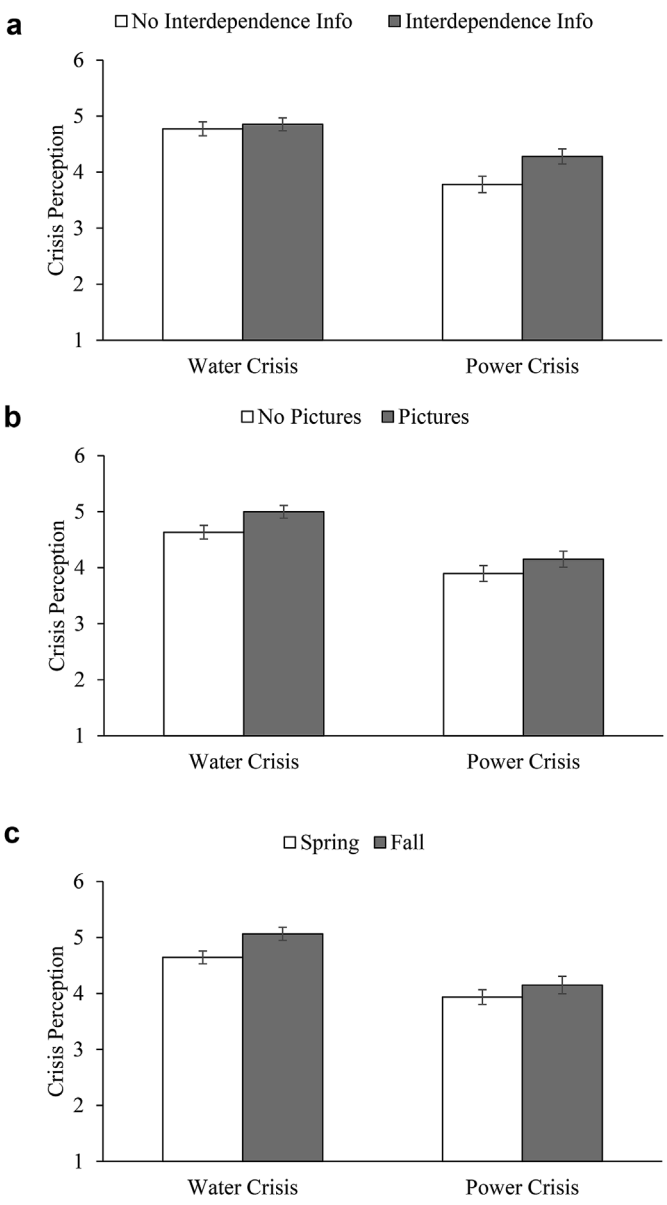

Fig. 1. Effect of the three manipulations on water and power crisis perception. The three manipulations included knowledge (Fig. 1a), vividness (Fig. 1b), and timing (Spring or Fall; Fig. 1c). Error bars represent 95% confidence intervals.

4. Discussion

The present findings demonstrated that knowledge, vividness, and timing each independently contributed to communicating the urgency and severity of an environmental crisis. These findings suggest novel implications for crisis communication strategies to be applied in future interventions confronting barriers to environmentally-responsible behaviors, particularly as they apply to a projected chronic water crisis in the Southwest United States.

4.1. Limitations and future directions

The current findings are encouraging and add to the literature on taking the social psychological perspective to understand factors that influence perceptions of environmental crisis (for reviews, see Swim et al., 2009; Weber, 2013). However, our study examined only a chronic water crisis in Arizona. Future research needs to address whether the three factors investigated in this study also apply to communications of other types of environmental disasters, as well as to other consequences that can stem from a water shortage. For instance, an interesting direction for future research is to study the impact of the three factors on other likely scenarios that may or may not be as salient to people, such as the possibility of rolling blackouts in Arizona due to power shortages. Another limitation of the present research is that our sample consisted of approximately 80% of white Americans. Thus, we were not able to examine ethnic differences in the effects of the three proposed factors, if any. Future research will need to ascertain whether effects of these factors on crisis perceptions observed in the current study generalize to other ethnic groups.

The Southwest region of the United States is particularly susceptible to chronic water crises in the near future. Our sample included a sample of Arizona's Maricopa county residents, so that our findings may be specific to this region. For instance, an interesting direction for future research is to examine whether there are regional differences in terms of timing. In Arizona, temperatures are high all year round and summers are particularly dry, with temperatures typically reaching over 100 °F. For this reason, the effect of timing on crisis perceptions may have been particularly pronounced in the present sample since needs to use heat-combating energy resources are salient and may overpower desires to conserve resources in weeks leading up to the intense summers.

Additionally, our timing manipulation involved two conditions within a single year (Fall 2016 to Spring 2017). The effects of the timing manipulation might stem from particular conditions of the study year. One could argue that the summer of 2016 was particularly hot and dry, the higher perceptions of urgency and severity observed in the fall condition could be due to the recent experience of a miserable summer. To address this possibility, we examine the monthly temperature data from the National Weather Service for the Phoenix area (Maricopa County). Its average temperature for the summer months of 2016 (94.60°) was aligned with the average temperature from the previous three years (94.64°). Similarly, the average precipitation for the summer months of 2016 (0.72 inches) was aligned with the average precipitation from the previous three years (0.67 inches). Furthermore, the average daily temperatures during the Fall data collection (November 21st through December 2nd, 2016) were lower (58.21° vs. 77.27°, respectively) than the average daily temperatures during the Spring data collection (May 5th to May 17th, 2017). If ratings of perceived severity and urgency are due to immediate weather conditions, we would expect that participants' ratings would have been higher in the Spring condition compared to the Fall condition. We found the opposite pattern of results in the current study. Therefore, the particular weather condition of the study year is not likely an alternative explanation for the observed findings.

The present research focused on perceptions of urgency and severity of water and power crises. Future research should extend it to include water- and power-conserving behavioral outcomes. Perceptions of a crisis are likely to influence environmental intentions and actual saving behaviors. For example, previous studies demonstrate that attitudes and perceived risk of an environmental crisis predict engagement in sustainable behaviors (Beckage et al., 2018; Sapci & Considine, 2014; Tikir & Lehmann, 2011). The framework explored in the present study could be applied to future interventions which, by communicating the intensity of a crisis, may influence individuals to engage in sustainable practices such as signing up for efficient energy usage plans. By assessing behavioral outcomes, future research will be able to demonstrate if knowledge, vividness, and timing variables have positive spillover effects on other pro-environmental behaviors. Positive spillover occurs when an intervention has positive effects on other behaviors not directly targeted by the intervention (see Truelove, Carrico, Weber, Raimi, & Vandenbergh, 2014). Possessing knowledge about the interdependence of water and power systems and having a vivid image of the impact of a water shortage may positively affect a variety of pro-environmental behaviors. Yet, factors that affect environmental perceptions will not necessarily affect behavioral outcomes. Future research is needed to test any spillover effects related to the three psychological factors included in the present study.

4.2. Implications

Previous studies assessing the effectiveness of information-intensive interventions have largely failed to promote engagement in environmentally responsible behaviors (Grob, 1995; McKenzie-Mohr, 2000). This is largely because these interventions often provide participants information that does not necessarily address specific barriers to their engagement in sustainable behaviors (Abrahamse et al., 2005). The present findings suggest that knowledge-based interventions may be most effective when the knowledge presented is not already salient. Presenting knowledge about the interdependence of the two infrastructures served to increase urgency of a power crisis. Nevertheless, perceptions of water crisis were not affected by this knowledge because urgency and severity of a water crisis were likely already apparent. Therefore, presenting knowledge about the interdependence of water and power systems may be an effective concept to present in targeted interventions seeking to increase urgency about power conservation during a water crisis and vice versa. Ecological-friendly behaviors often depend on a convergence of different types of knowledge (Kaiser & Fuhrer, 2003). Providing information about the interdependence of water and power systems may have provided participants novel information about the impact water shortages on the supply of power, influencing their perceived urgency and severity of a power crisis. If the impact of water shortages on the supply of water is already apparent to individuals, providing information about the interdependence of water and power systems might not affect their knowledge relating to a water crisis. Future research needs to examine the contexts in which interdependent knowledge extends the effect of general knowledge of environmental consequences on crisis perceptions.

The exploration of vividness in the current study is instrumental in that the presented frame utilizes imagery of declining water levels. The effectiveness of the presented frame supports previous findings that a future orientation is related to sustainable behaviors (Arnocky, Milfont, & Nicol, 2014; Corral-Verdugo & Pinheiro, 2006) and suggests that a vividness manipulation could serve as a potential means to increase consideration of future consequences related to environmental crises.

Notably, the current study is the first to establish the importance of considering timing in studying environmental crisis perception and taking into account competing needs to conserve and use scarce resources. By understanding what timing is best to promote the urgency of environmental crises, suppliers may get users to commit to long-term sustainable options. Future research may consider the importance of timing in implementing campaigns for water and power conservation efforts. By pairing interventions seeking to decrease the competing

nature between current actions and future environmental consequences with optimal timing of appeal campaigns, we may be able to optimize behavioral changes in electricity conservation and water resource management to promote sustainability of scarce natural resources.

The significant findings observed in the current study were small in effect size. When a domain of study involves deleterious and consequential outcomes, such as the impact of water shortages on the supply of water and power, a better understanding of even potentially smaller-sized effects can have practical importance for policy makers and intervention designers. However, future research will need to investigate additional factors that impact water- and power-conserving attitudes and behaviors. The result of this line of research will be a more complete understanding of the factors that contribute to the pro-environmental perceptions and behaviors that are vital to address environmental crises, such as an impending megadrought in the Southwest United States.

5. Conclusions

The proposed manipulations successfully influenced perceptions of urgency and severity about an environmental crisis and expands the literature on applications of psychological frameworks to creating effective communication of impending crises. Specifically, the current study provides valuable insight into factors that impact communication of the urgency and severity of an extreme chronic water crisis. These identified strategies may inform governments, suppliers, and the general public about effective methods to address real-world challenges such as the impending threat of a megadrought.

Declarations of interest

None.

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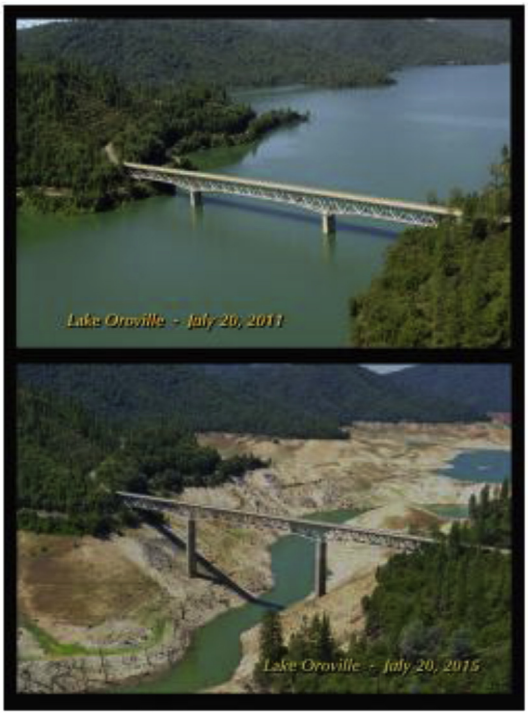
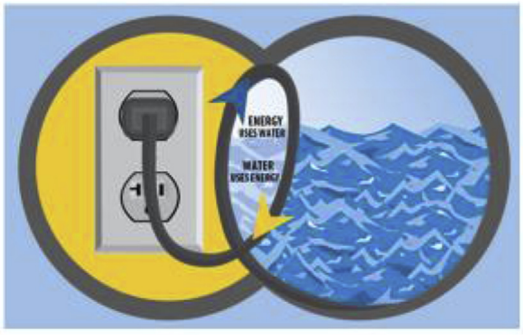
Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jenvp.2019.01.003.

Appendix





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